Center Innovation Fund: KSC CIF

A Far-Field Electro-Magnetic Tractor Beam

Completed Technology Project (2011 - 2012)

Project Introduction

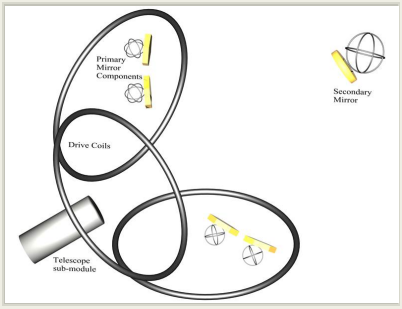
The goal of this project was to demonstrate and model a cooperative, attractive, longrange force between a pair of satellites. NASA needs such a capability in order to fly satellite formations for future interferometer and telescope applications. The NASA Innovative Advanced Concepts (NIAC) program funded three different efforts in an attempt to develop this capability, all of which suffered from serious limitations. We believed we could succeed where others had failed by using an antenna on one satellite to beam an electromagnetic signal to a second satellite on which an antenna was being driven synchronously with the incoming wave.

When the project began, our intention was to develop a more accurate model of the forces that could be obtained between experimentally demonstrate these forces. We chose to operate at a frequency of 2.2 GHz and spent the next six months developing a torsion balance system to monitor the force between a fixed antenna and one that was suspended. In addition, we developed a theoretical model for this force that, by April 2012, led us to conclude that the attractive (or tractor beam) forces that could be achieved in this manner were too small. We had hoped for forces at the micro-Newton level, but were only seeing them at the nano-Newton level, which is insufficient for many applications.

Consequently, we redirected our work to the goal of developing a shortrange tractor force between satellites, with great success. Over the next few months, we showed that, within a distance of roughly 100 m, it was feasible to construct a satellite position and orientation system that would allow a next-generation large space telescope to be built with freely floating mirror elements. We verified our predictions experimentally and showed that not only could the entire telescope be steered to a point anywhere in the sky within a few hours, but each element could be stably held to the optical wavelength criteria necessary for diffraction-limited performance.

Anticipated Benefits

One application of a satellite positioning and orientation concept would be the creation of a next generation large aperture telescope. This technology may allow the eventual construction of a multi-mirror telescope composed of a large number of free flying mirror elements and the freedom to accurately position and orient small satellites relative to one another.



In this conceptual image only four out of the 60 mirrors proposed for the primary reflector are shown and they are not to scale with the drive coils.

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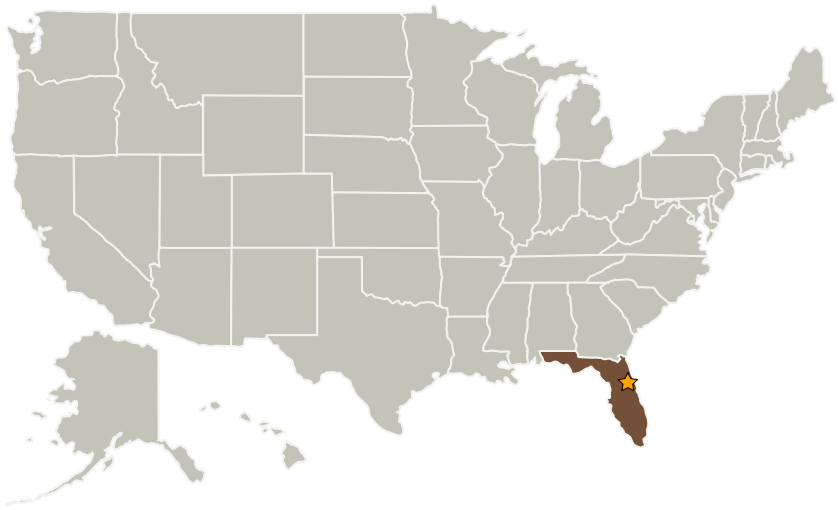
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
QinetiQ North America(QNA)	Supporting Organization	Industry	

Primary U.S. Work Locations
Florida

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Center Innovation Fund: KSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Barbara L Brown

Project Manager:

Nancy P Zeitlin

Principal Investigator:

Robert C Youngquist

Co-Investigator:

Stanley O Starr

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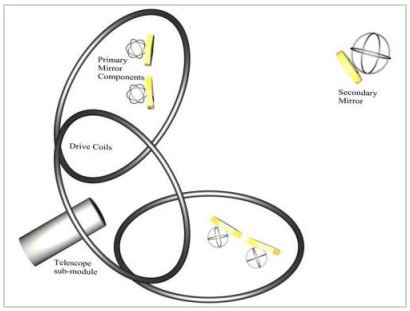
Images



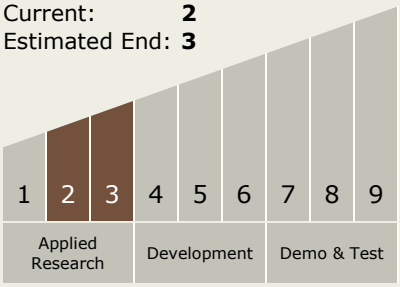
Conceptual Image of Telescope Utilizing Alternating Magnetic Field Forces
In this conceptual image only four out of the 60 mirrors proposed for the primary reflector are shown and they are not to scale with the drive coils.
(https://techport.nasa.gov/image/2124)

Stories

Alternating Magnetic Field Forces for Satellite Formation Flying
(https://techport.nasa.gov/file/2568)

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.1 Mirror Systems